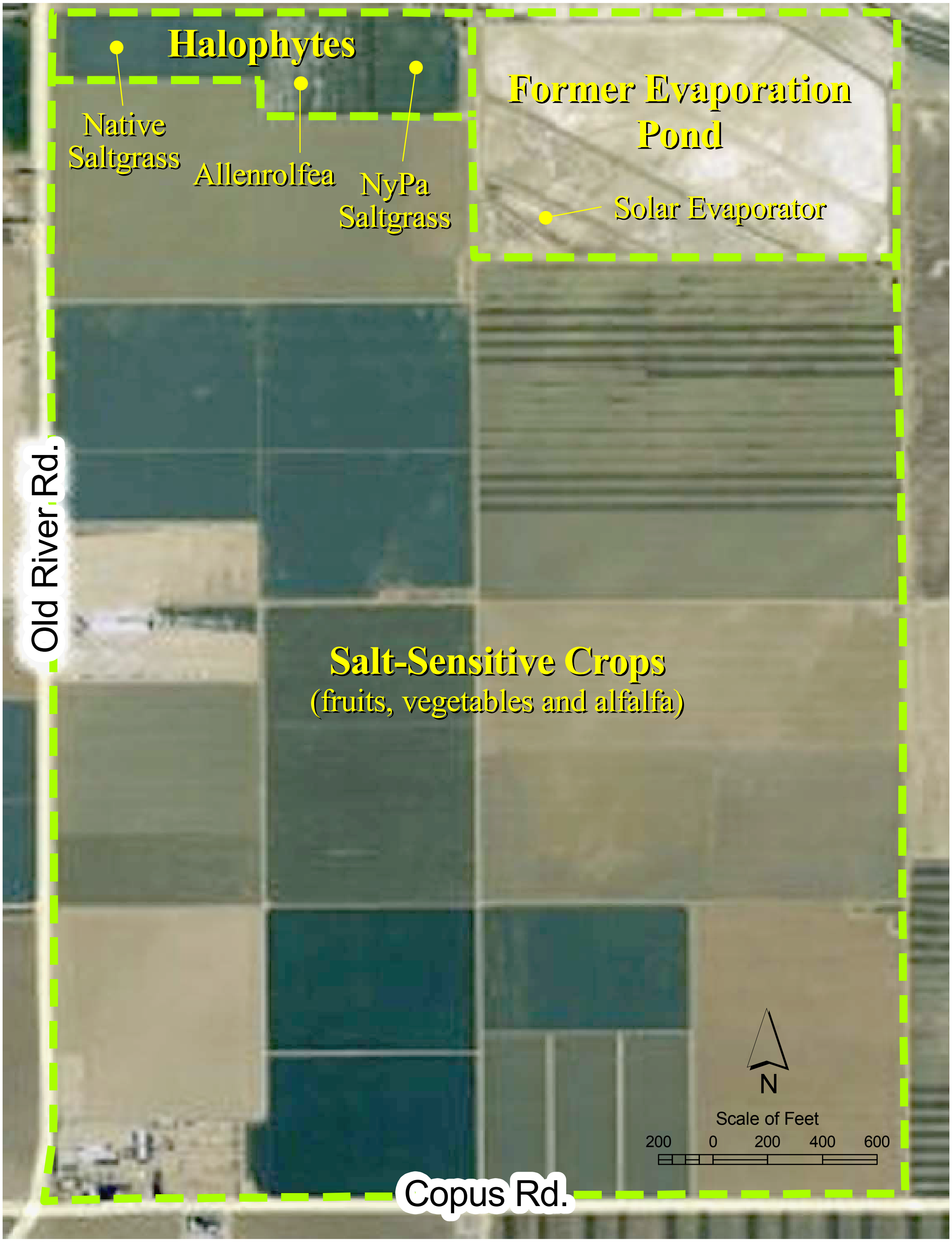
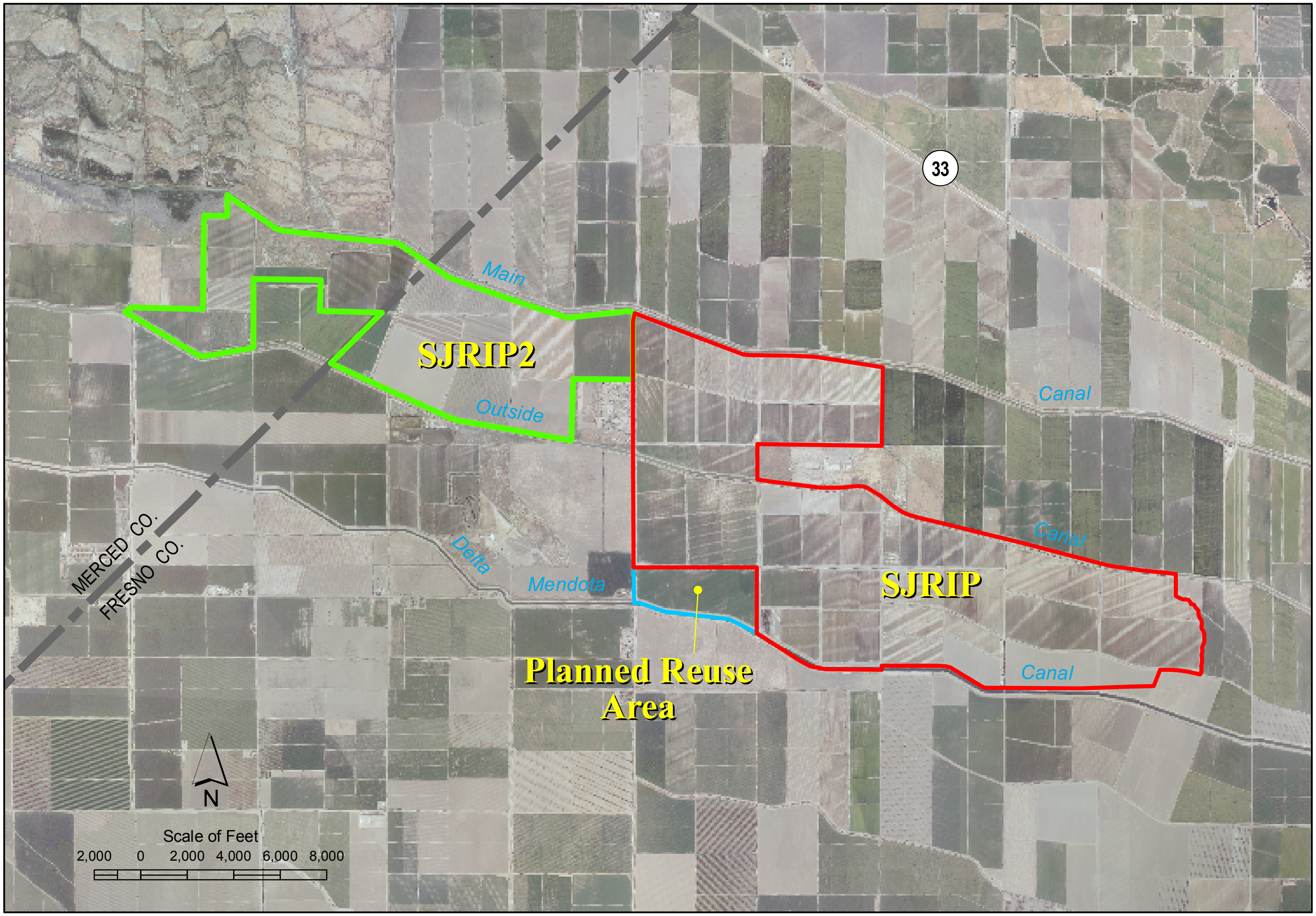


Halophytes
Native Saltgrass
Allenrolfea
NyPa Saltgrass
Former Evaporation Pond
Solar Evaporator
Salt-Sensitive Crops
(fruits, vegetables and alfalfa)
Old River Rd.
Copus Rd.
N
Scale of Feet
200 0 200 400 600



San Joaquin River Water Quality Improvement Project (SJRIP) Regional Water Reuse Areas

Case Study 2: Integrated On-Farm Drainage Management---A Farm-level Solution to Problem Salinity

In the late 1990's, the 1,200-acre AndrewsAg farm in Kern County was a cotton and alfalfa operation, and drainage water from the farm was discharged to a 100-acre evaporation pond. Unfortunately, the high concentrations of salts and selenium in the pond posed a serious risk to wildlife. To develop a practical farming system that would eliminate the evaporation pond as the final disposal point for the drainage water, and, therefore, provide a safe environment for wildlife, AndrewsAg switched to the Integrated On-Farm Drainage Management (IFDM) farming system, which was first pioneered at Red Rock Ranch in Fresno County.

IFDM is an integrated agricultural water management system in which subsurface drainage water is applied sequentially to increasingly salt-tolerant crops. Drainage water from irrigating salt-sensitive crops can be reused, to a given level of salinity, to irrigate salt-tolerant crops. The number of steps comprising the reuse sequence can vary, as can the crops to which the drainage water is applied at each stage of the sequence. Once the drainage water becomes too salty to grow any crops, the remaining drainage effluent from the final stage in the sequence of reuse is evaporated in a solar evaporator, leaving crystallized salts behind. In the solar evaporator, the concentrated drainage water is distributed using timed sprinklers or other equipment that allows the discharge rate to be set and adjusted so that water does not pond on the surface of the solar evaporator. The dry salt mixture may contain chemicals of commercial value that can be harvested.

AndrewsAg has now been using the IFDM system on 1,200 acres for about 10 years, and has successfully managed drainage water, salt, and selenium in an ecologically sound way to grow a variety of high-value crops. The AndrewsAg IFDM system starts with low salinity water to irrigate salt-sensitive, high-value fruit and vegetable crops and alfalfa. For many years subsurface drainage water from this low-salinity zone was applied to salt-tolerant crops such as cotton and the subsurface drainage water collected from this first reuse was applied to a high salinity zone of salt loving plants called halophytes, both applications reduce the volume of drainage water and take up salt and selenium. Finally, drainage water from the high-salinity zone is evaporated by the solar evaporator. Most recently AndrewsAg installed a high efficiency drip irrigation system on the farm; resulting in the elimination the first reuse step on the IFDM system.

The photo illustrates the layout of the IFDM system on the AndrewsAg farm. Salt-tolerant crops (halophytes) are in the NW corner of the farm. The solar evaporator is in the NE corner of the farm within the area of the former evaporation pond, but only occupies 20% of the area of the abandoned evaporation pond. Fruit and vegetable crops and alfalfa are grown on approximately 1,140 acres (95%), halophytes are grown on 40 acres (3.3%), and the solar evaporator occupies 20 acres (1.7%).

(Insert Figure)

Case Study 2A---San Joaquin River Water Quality Improvement Project -A Regional Solution to Problem Salinity

The Grassland Drainage Area (GDA) is an agricultural region on the Westside of the San Joaquin Valley. The agricultural land there is productive, but the soils contain high levels of naturally-occurring salts, trace elements, such as selenium, and boron. The salts and trace elements are leached from the soil when the fields are irrigated, and accumulate in the agricultural drainage water that is collected in drainage pipes commonly called tile drains that farmers have installed in their fields to protect their crops from waterlogging conditions. Until the 1990s, drainage water from the GDA that contained high concentrations of selenium, salts, and other constituents that are harmful to fish and wildlife was discharged directly to waterways that delivered water to wetland areas.

In 1996 several irrigation and drainage districts formed the Grassland Area Farmers, a regional drainage entity that comprises approximately 97,000 acres of irrigated farmland. The Grassland Area Farmers were faced with the challenges of maintaining agricultural production in a region faced with shallow groundwater and naturally-occurring salts, and reducing and eventually eliminating all farm drainage discharge from the region.

The Grassland Bypass Project was initiated in 1998 to separate good-quality water upslope of the Grassland Drainage Area from drainage water by consolidating subsurface drainage water from GDA into a single channel (Grasslands Bypass Channel, constructed in 1996) into the San Luis Drain. The drainage water is discharged through the San Luis Drain to Mud Slough, approximately 8 miles upstream of the San Joaquin River.

To manage and reduce the drainage discharge to the San Joaquin River, Grassland Area Farmers are making irrigation and infrastructure improvements to reduce the amount of water that is applied. By pumping groundwater above the Corcoran clay layer and using that groundwater for irrigation, Grasslands Area Farmers are lowering the perched water table to reduce the amount of groundwater entering the subsurface drains. Finally, Grasslands Area Farmers are reusing drainage water by implementing a regional version of the Integrated On-Farm Drainage Management (IFDM) system on their 97,000 acres, where each phase of reuse significantly reduces the quantity of subsurface agricultural drainage water.

From 1997 to 2000, Grassland Area Farmers began recirculation projects where a portion of the drainage water is collected and re-circulated back into irrigation distribution systems and blended with fresh water for use on crops. In 2001, the San Joaquin River Water Quality Improvement Project (SJRIP), which is an IFDM system, was implemented. 4,000 acres were purchased for the reuse area, some salt-tolerant crops were planted in the winter of 2001, and distribution facilities were constructed that allowed 1,821 acres to be irrigated with drainage water and/or blended water. Sub-surface drainage systems were installed in 2002, salt-tolerant crops, including Jose Tall Wheatgrass, Bermuda and fescue pasture, pistachio trees, and alfalfa were planted in the reuse area. The following year more subsurface drainage systems were added and halophytes were planted on 153 acres.

The Grassland Area Farmers continue to use and expand the SJRIP, and by 2010 the total acreage of the SJRIP had increased to more than 6,000 acres, with approximately 5,100 developed to salt-tolerant crops for drainage reuse. Approximately 12,400 acre-feet of drainage water was reused on the SJRIP in 2010.

From 1995 (before projects) to 2010, drainage water discharge volumes, as well as selenium, boron, and salt loads have been reduced significantly. More than 57,500 acre-feet of drainage water was discharged through drainage canals in 1995 before the establishment of the Grassland Bypass Project. By 2010, that amount of drainage water had been reduced to 14,400 acre-feet, a 75% reduction. During that period, the amounts of selenium, salt, and boron had dropped 87%, 72%, and 64%, respectively.

The actions taken by the Grassland Area Farmers have led to significant selenium load reductions, and several water bodies in the Grassland Watershed that were listed as impaired because of the high selenium levels have been de-listed. The U.S. EPA considers this project a "nonpoint source program success story."

As more of the reuse area is developed, and the operational flexibility and efficiency of the SJRIP improve; as more high-efficiency drip and micro-sprinkler irrigation systems are installed; and as new wells are installed to pump water from the perched water table and recycled to irrigate crops, the drainage volumes and associated salts and trace elements are expected to continue to decrease. However, although substantial progress has been made, additional work is required to achieve the ultimate goal of zero discharge. The final step for the remaining drainage water will be collection of the brine from the reuse area for further treatment and disposal by non-agricultural processes.

Reverse osmosis (RO) desalination has been tested, in which drainage water is forced through a membrane to separate contaminants from the water. This process produces one stream of very good quality water and a second stream of concentrated brine. To remove selenium from the concentrated brine, pilot-testing of various innovative treatment technologies are being performed. For example, salts from the brine such as calcium sulfate (gypsum), sodium chloride, and sodium sulfate could be separated and recycled. In addition the U. S. Bureau of Reclamation is building a pilot treatment facility to be operational in 2013 that will test various drainage treatment processes.

Salt Management in the Santa Ana Watershed Requires Regional Salt Disposal Options

The Inland Empire Brine Line has allowed us to use groundwater from salt-degraded aquifers and capacity in that line will be the limiting factor in our future groundwater recovery and recycling efforts. - Don Galliano, Board Member, Western Municipal Water District

Benefits:

- Allows use of groundwater resources from aquifers having too much salt or other contaminant for use.
- Protects and improves groundwater quality through salt and contaminant removal
- Allows industry to take advantage of Inland Empire opportunities and meet salt discharge standards for water used in industrial process
- Orange County groundwater aquifers protected and do not require additional desalting

Brine Line Partnering Agencies

- San Bernardino Valley MWD
- Eastern MWD
- Western MWD
- Inland Empire Utilities Agency
- Orange County Sanitation District

Salt concentrations in the region's underground aquifers have increased over time as a result of historic agricultural and industrial practices, and the use of higher-salinity imported water. In some instances, high salt concentrations limit the potential to make use of local groundwater sources. For this reason, brackish-groundwater desalination facilities have been constructed in the watershed to remove salt and provide needed drinking water sources, but desalination results in a concentrated stream of high-salinity brine that needs to be disposed of outside the watershed. Furthermore, the establishment of certain types of water-intensive industries, such as power plants, food processors and technology businesses in the watershed, also requires a vehicle for the safe disposal of concentrated salt water that cannot go to sanitary sewers.

The Inland Empire Brine Line, also known as the Santa Ana River Interceptor (SARI) system, was constructed in phases over a period of 20 years, stemming from a vision articulated in the early 1970's of a salt-balanced watershed. The SARI is a complex system of 93 miles of pipelines that collects high-salinity flows from throughout the watershed and conveys them to an Orange County Sanitation District treatment facility prior to discharge to the Pacific Ocean. Flows collected by the SARI could not go to local sanitary sewers and wastewater treatment plants due to its high salinity, which adversely affect the ability to reclaim and reuse wastewater.

The construction of this important infrastructure work was the result of a cooperative approach requiring coordination by several water agencies and a holistic, integrated view of water management in

Those needing to dispose of salt in the Inland Empire have a cost advantage over those in the rest of the LA Basin as the result of the Brine Line partnership.

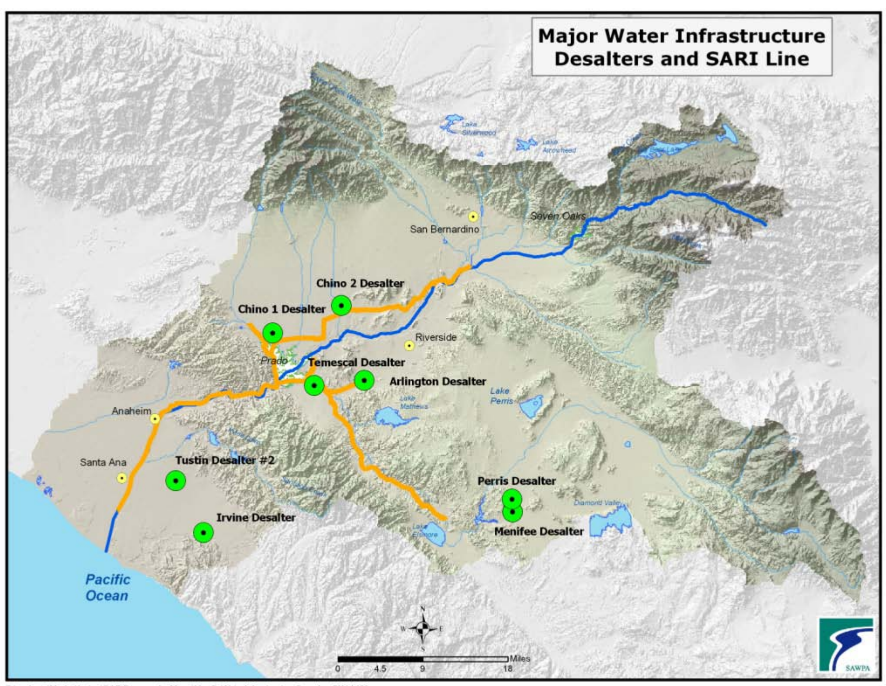
Groundwater basins are cleaned, additional local water supply is available, and industry benefits.

the watershed. This multi-agency participation has allowed the construction of an impressive system that could not have been implemented by a single agency.

Using a novel partnership model, the SARI was constructed with loans that were repaid using revenue generated from the sale of capacity in the system to those anticipating desalting needs. Operation and maintenance continues to be funded with revenue and capital reserves generated from rates. In addition, capital-intensive improvements may be funded through debt financing.

Currently, users that own capacity to the SARI pay approximately 1.1 cents per gallon disposed for operation and maintenance (O&M). New users who wish to acquire capacity would pay in the order of 1.2 cents per gallon, for both O&M and capacity fees amortization.

Alternatively, utilizing the Los Angeles County NRW line, the only other brine line in the region, would cost users in the order of 2.0 cents per gallon, assuming a new line is needed to connect users in the watershed to the NWR. This cost is approximately 80% more than the SARI alternative. For an average flow of 12 mgd, the use of the SARI represents savings of $35million per year to users in the watershed compared to NWR. Other alternatives, such as hauling brine, currently at a cost of approximately 25 cents per gallon, are simply unrealistic for large scale desalination or industrial processes



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DRAFT CV-SALTS Case Study Text

Nowhere in California is salinity a more significant threat to sustainability than the Central Valley. Salinity threatens the long-term reliability of water supplies and community quality as groundwater basins are impacted and farmland goes out of production.

In 2007, area stakeholders, the Central Valley Regional Water Quality Control Board and State Water Resources Control Board initiated a unique collaborative salinity management effort modeled in part on the on the Santa Ana Watershed approach described elsewhere, only on a much grander scale.

The Central Valley region is comprised of three major basins and covers a 60,000 square mile area, extending from the Tehachapi Mountains in the south to the Oregon border in the north. CV-SALTS (Central Valley Salinity Alternatives for Long Term Sustainability) is an initiative to address salinity throughout the region and Delta in a comprehensive, consistent, and sustainable manner through the development of a Salt and Nitrate Management Plan for the Central Valley. Like the efforts through SAWPA, CV-SALTS encourages stakeholder-initiated actions and leadership that can accomplish management that the Regional Water Boards are unable to require but which will make it possible to achieve and maintain sustainable salinity management in the region.

Several working bodies are currently active in the CV-SALTS initiative. The Water Boards provided initial support and continue to play key advisory roles. The Central Valley Salinity Coalition a strong initial and ongoing funder of the CV-SALTS initiative has as members the Statewide and regional associations, agricultural coalitions, cities counties and special districts representing a majority of the Central Valley. The Executive committee charged with the governance of this broad reaching initiative has representatives from the Central Valley Salinity Coalition as well as representatives from in the State, federal, and local governments; nongovernment, environmental justice and industry organizations. The Technical Advisory committee includes top researchers and consultants in the field to review scientific and technical issues and economics. Other committees made up of stakeholders serve as technical reviewers of management practices, conduct outreach, review economic and technical studies, and related efforts. These efforts will develop the science and policy required to review and update the Water Quality Control Plans for the Sacramento and San Joaquin River Basins, the Tulare Lake Basin, and the Delta Plan.

More information on the CV-SALTS committees or the Central Valley Salinity Coalition is available on the initiative website at: _______________ .

Table 18-2. Incremental Costs to Remove Chloride from Municipal Waste

City: Dixon
Population: 18,000
Location: West side of the Central valley

Water Source: Groundwater, good quality, high hardness (Chloride 15 mg/l, Total Hardness 260 mg/l)
Raw Wastewater: 1.3 Mgal/day Average annual flow, Chloride 130 mg/l
Wastewater Treatment (WWTP) Technology: Stabilization Ponds
WWTP Effluent: Chloride approximately 180 mg/l, annual average.
Wastewater Discharge: Land disposal (slow-rate percolation basins)
Proposed Discharge Limit: Chloride 106 mg/l, 12 month sliding average

Incremental Costs to remove or mitigate approximately 30% of the City's wastewater chloride load to local groundwater (1)				
	Cost in $Millions (2)			
Project Description	Capital	Annual O&M	Total Cost (3)	Notes
Public education, source characterization studies, *first community to adopt a residential self-regenerating softener ban under AB 1366*, and residential self-regenerating softener removal incentive program ($1,200 - $600 per unit).	$ 0.42	$ 0.16	$ 2.8	Approx. 300 units removed, O&M costs included are for those units changing to canister exchange units at $30/month net cost and cost associated with a large commercial discharger softening cooling water with KCl regenerated canister exchange softeners to meet sodium and chloride discharge limits. *Such O&M costs would not be reflected in general water and/or wastewater rate structure*
Fallowing of farmland (that utilize low quality tailwater and/or groundwater)	$ 1.5	$ 0.10	$ 3.0	Approximately 300 acres at $5,000/acre, nominal "caretaker" O&M costs assumed. Does not include other general costs associated with loss of local farmland, or the habitat benefits of such conversion. The City comprises approximately 1,600 acres and would require an offset of approximately the same magnitude to mitigate 100% of its chloride load, if the water sources were of similar quality. *In other words, the impact of agricultural land use and (medium density) residential community land use is approximately equal, on an acre for acre basis.* A similar result was found in salinity anti-degradation analyses performed for other Central Valley communities such as
Injection of high quality surface water into groundwater	$ 3.6	$ 0.20	$ 6.6	Includes cost of water at $160/AF, collection, disinfection, and injection facilities
Blending of high quality surface water with WWTP effluent	$ 6.3	$ 0.18	$ 9.0	Includes cost of water (approximately 1,000 AF) at $160/AF, delivery and additional disposal facilities, requires approximately 20% more water than direct injection into groundwater project to mitigate for evaporative losses in the percolation basins
Change to Activated Sludge (high rate/bubble aerated) Treatment	$ 9.5	$ 0.14	$ 12	Mitigation via reduced loss of water due to evaporation compared to slow rate "natural" treatment system
Removal from Groundwater by Reverse Osmosis	$ 9.0	$ 0.35	$ 14	Pump, treat, and reinject groundwater (4)
Removal from the WWTP effluent by Electrodialysis Reversal	$ 20	$ 0.49	$ 27	Treat a portion of WWTP aerated pond effluent (4)
Change to a surface potable water supply	$ 45	$ 0.70	$ 55	Includes cost of water at $40/AF, raw water conveyance improvements, treatment plant, distribution mains for average use, wells remain for peak demand. Annual costs do not include reduction in costs of operation for the existing well water system. Removal/mitigation of chloride for this project may exceed the 30% benchmark
Soften potable water at the well heads	$ 32	$ 2.0	$ 62	Nanofiltration at 5 of 14 well sites with reject stream concentrate management via on-site calcium pellet removal and discharge of remaining magnesium rich reject stream to the sewer. Does not include land acquisition/condemnation costs that may be necessary. Cost would fall significantly if total reject stream could be directly discharged to the sewer, and the resultant TDS (hardness) load increase to the WWTP is deemed acceptable

(1) The incremental costs presented are in addition to the $13 million project refurbishing the existing (60 year old) stabilization pond WWTP in kind. A 30% chloride reduction is chosen for benchmark purposes, actual reduction required to achieve compliance with discharge limits may be less than, or exceed, 30% and may include aspects of several project approaches, including source control, WWTP improvements, and site specific discharge limit adjustments. A 30% chloride reduction is approximately 420 pounds/day. Benchmark intent is to facilitate economic comparisons between apparent least cost implementation of a particular project approach. No plan has been funded to date except for the public education and softener removal incentive program. Project cost is only one factor that may

(2) All costs except the education/softener exchange program are AACE (Level 1) conceptual costs estimates. Softener exchange program capital costs represents actual incentive program capital costs for the first 300 units removed

(3)Total costs presented as 20 year Present Worth, assuming 3% net interest rate. *Typical residential rates may increase approximately $1/month for each $1 million in total project costs.*

(4) Brine handling via, concentration, yearly on-site storage with seasonal solar drying, and removal of dry residue to land fill disposal, apparent cost lower than hauling of brine concentrate to EBMUD Oakland facility

Primary Reference: City of Dixon DRAFT Facilities Plan, August 2011, Stantec (conceptual peer review by Brown and Caldwell). Secondary reference: Technical Memorandums for City of Dixon, ECO:LOGIC and Stantec; and personal communication with City staff and commercial dischargers.

Table 18-3. Value of reclaimed water and recyclable salts present in a typical Agricultural drainage water sump in the San Joaquin Valley

Drainage Water Volume, af	1
Drainage Water Weight, tons	1,359
Conductivity, dS/cm	15,735
Total Dissolved Salts, mg/l	11,733
Salt Volume, tons	16

Water composition:

	% Weight	Weight (ton)	Value $/ton	Unit Value	% Value
Water [H2O]	98.77%	1359	0.25	340	13.83%
Calcium Bicarbonate [Ca(HCO3)2]	0.03%	0.34	50	17	0.12%
Calcium Sulfate [CaSO4]	0.18%	2.41	33	79	3.57%
Boron as boric acid [B(OH)3]	0.01%	0.18	360	64	3.75%
Sodium Chloride [NaCl]	0.42%	5.73	35	201	7.08%
Magnesium Chloride [MgCl2]	0.08%	1.14	300	342	14.38%
Sodium Nitrate [NaNO3]	0.05%	0.70	390	274	10.40%
Potassium Chloride [KCl]	0.00%	0.01	600	8	0.09%
Selenium [Se]	0.00%	0.001	70,000	96	4.35%
Sodium Sulfate [Na2SO4]	0.47%	6.41	140	897	42.43%
	100.00%			$2,319	100.00%

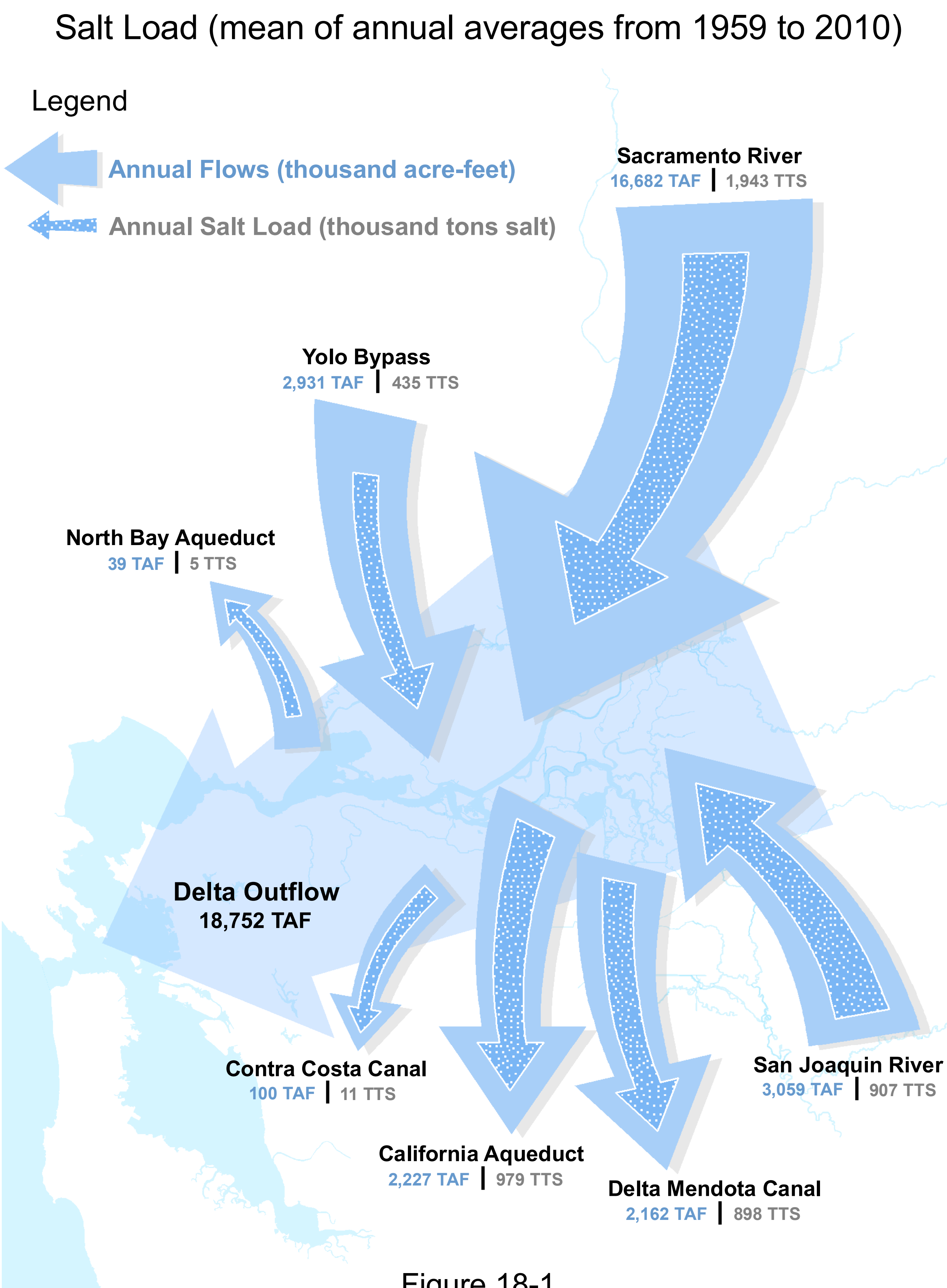
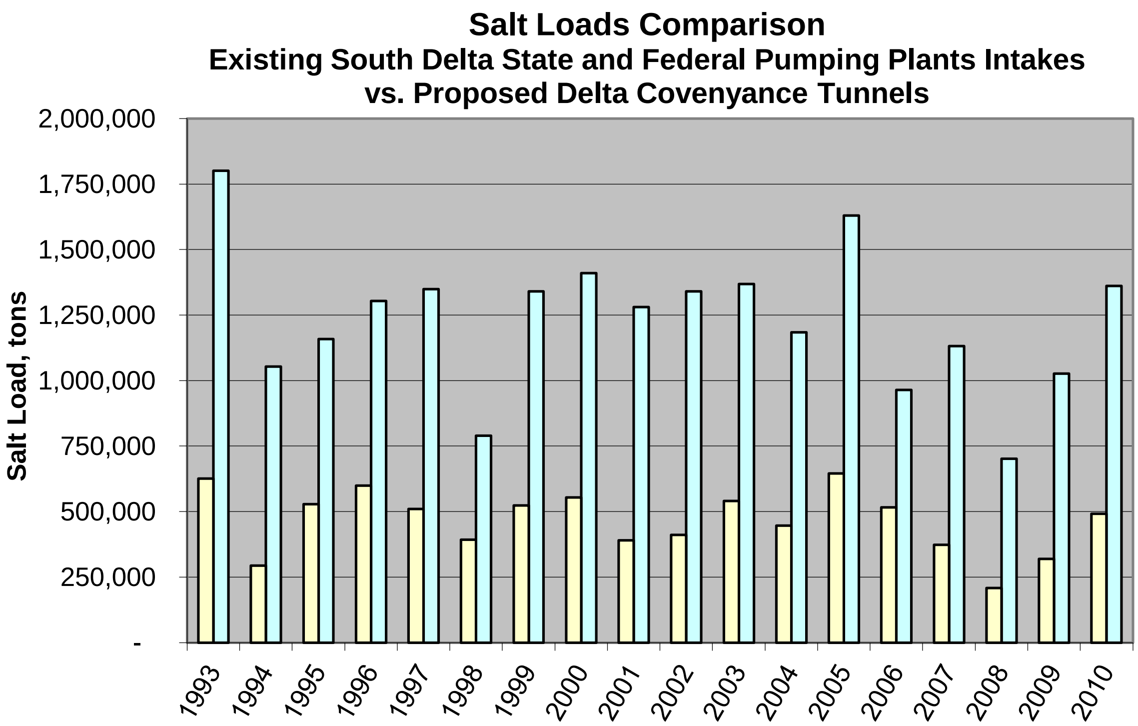

Salt Load (mean of annual averages from 1959 to 2010)
Legend
Annual Flows (thousand acre-feet)
Annual Salt Load (thousand tons salt)
Sacramento River
16,682 TAF | 1,943 TTS
Yolo Bypass
2,931 TAF | 435 TTS
North Bay Aqueduct
39 TAF | 5 TTS
Delta Outflow
18,752 TAF
Contra Costa Canal
100 TAF | 11 TTS
California Aqueduct
2,227 TAF | 979 TTS
Delta Mendota Canal
2,162 TAF | 898 TTS
San Joaquin River
3,059 TAF | 907 TTS

Figure 18-1

Federal and State Water Projects

Figure 18-4



Blue, Existing State and Federal Facilities
Yellow, Delta Conveyance Tunnels